March 28, 1989

TO: Lens Division
    Lens Technical Committee
    PAL Task Force

OMA FINALIZES PAL STANDARD

OMA is indeed proud to enclose the PAL standard approved by the ANSI-Z80 Committee. It will be presented to the International Standards Organization when it meets this fall in Australia.

Our highest congratulations to Dave LaMarre who did a superb job in this effort together with his Task Force of Steve Drake, Tom Posin, Mark Mattison-Shupnick and John Young.

Cordially,

Eugene A. Keeney
Executive Vice President

gm/EAK

Enclosure

+ Thanks, Dave!
1. Scope and Field of Application

This standard establishes the optical, mechanical, geometric and special specifications to be met by semifinished progressive addition ophthalmic lens blanks. This standard does not apply to blended bifocals.

There are several ophthalmic lens styles for the correction of presbyopia. These may be divided into two classifications. The first classification is multifocal lenses; these lenses have distinct, clearly marked, areas of constant power. The second type of lenses is progressive addition lenses (PALs) in which the power progresses in a continuous smooth, designed rate of change from the distance viewing area into the near viewing area. This category of lenses requires different kinds of reference points from bifocals and trifocals. For this reason a progressive lens standard is necessary.

Progressive addition lenses have reference points for distance vision, near vision, fitting the lenses to the face, and measuring prism. Definitions of these important reference points are incorporated in this standard.
The progressive addition lens is significantly different from bifocal or trifocal lenses in concept. The progressive addition lens has an area of designed rate of change of power. The designed rate of change affects not only the progression of power from distance to near viewing, but also the optical characteristics in the peripheral portion of the lens. The regular bifocal has a segment of a prescribed size and shape in which the power differs from the power outside the segment; examples of bifocals are straight top, round segment, and blended bifocals. The blended bifocal is different from the regular bifocal in that the edge of the segment is blended to the spherical portion of the lens. This blending removes the visible line of demarcation and thereby can cause confusion with the PAL.

The standard will define each of the reference points and a comparison illustration is provided below (or in section XXX) to assist in the identification of these points.

2. References

ANSI Z80.1 - Recommendations for prescription ophthalmic lenses
ISO 4007: Eye-Protection-Vocabulary
ISO 7944: Optics and Optical Instruments - Reference Wave-lengths.
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ISO 4007: Eye-Protection-Vocabulary
ISO 7944: Optics and Optical Instruments - Reference Wave-lengths.
ISO 8598: Optics and Optical Instruments - Focimeters
Publication CIE 17: International Lighting Vocabulary
DIS ISO 8980/1

3. Definitions (a more complete list of ophthalmic definitions appears in ANSI Z80.1)

4.1 Add Power

The refractive power of the addition as measured by the method described in Appendix A 1.2 in ANSI Z80.1 1987 except that the measurement points are the near reference point and the distance reference point.

4.2 Distance Reference Point

That point on a lens blank where the manufacturer designates distance sphere power, cylinder power, and axis shall be measured on the finished lens produced from the blank.

4.3 Fitting Point

That point on a lens blank which the manufacturer designates as a reference point for positioning the lens produced from the blank in front of a patient's eye.
4.4 **Horizontal Reference Markings (0-180 deg. Line)**

The markings provided by manufacturers to establish the proper rotational alignment of the lens blank (0-180 deg. line).

4.5 **Near Reference Point**

That point on a lens blank at which the manufacturer designates that the specified add power can be verified.

4.6 **Prism Reference Point**

That point on a lens blank where the manufacturer designates that prism values of the finished lens are determined. Prism measured will be the resultant of prescribed prism and prism thinning. (Note: the prescribed prism will be equal to the difference between measured prism and prism from prism thinning.) This point is often called the Major Reference Point (MRP), but this is not correct, since in most PAL's today the Prism Reference Point and Distance Reference Point do not coincide. (Compare ANSI Z80.1 1987 Section 3.22 and figure E1 with the definitions and figures in this standard.) In the case of the lens made from the semi-finished blank, the prism at the prism reference point should correspond to the thinning prism specified, plus prescribed prism.
4.7 Prism Thinning

The lower portions of PALs by virtue of add tend to be thinner than the upper portions (see diagram A). In order to reduce thickness and weight it is possible to surface the rear of both lenses of a pair with equal amounts of base-down prism (see diagram B). If this technique is employed, the manufacturer's recommendations should be considered because the optimal vertical prism is dependent on the add power, lens design, and other factors. Addition of base down prism, according to the manufacturers recommendation produces a lens with more balanced edge thickness and thinner top.

4.8 Progressive Addition Semifinished Blanks

Semifinished blanks are composed of two surfaces; a finished surface and an unfinished surface. Progressive addition semifinished blanks are blanks which after surfacing are designed to provide correction for more than one viewing distance and in which the power changes continuously rather than discretely.

4.9 Surface Cylinder Power

The difference between the surface powers of the principal meridians on the finished surface.
4.12 Surface Power

4.12.1 Marked or Nominal

The nominal surface power (base curve) of a semifinished lens blank as expressed in diopters by the manufacturer. The nominal second surface power is expressed in diopters of tool power.

4.12.2 Refractive

Refractive (Ft) (also called True Power). The refractive power of a lens surface is the ability to change the reduced vergence of a small bundle of rays normal to the surface and is expressed in diopters:

\[
\frac{n' - n}{u'} = Ft = \frac{n' - n}{r};
\]

where
- \(u\) = object distance,
- \(u'\) = image distance,
- \(r\) = radius of curvature of the lens surface,
- \(n\) = index of refraction of the air, and
- \(n'\) = index of refraction of the lens material.
4.12.3 Tool

By common usage in the United States, a tool with a radius of curvature of 530 mm will produce a surface tool power (Fs) of 1 diopter. Tool power is defined as follows: $Fs = \frac{530}{r}$ where $r$ = the actual radius of curvature in millimeters (mm) for the surface it produces. Tool power is positive when the surface is convex, negative when concave. The term "surface power," when unqualified, refers to tool power. Lens measures used to measure surface power are calibrated in terms of tool power ($n' = 1.53$).

5 General Specifications

5.1 Optical Tolerances

5.1.1 Surface Power

The tolerance on true spherical equivalent surface power ($Ft1 + Ft2)/2$, when measured at the distance reference point, is $+ or - 0.09D$. The tolerance on surface cylinder power $Ft2 - Ft1$, when measured at the distance reference point, is $+ or - 0.09D$. 
5.1.2 Add Power

The tolerance on refractive power of the addition, when measured by the method described in 4.1, shall be $+\text{ or } -\text{ 0.13D}$ from the manufacturer's specified value.

5.2 Material and Surface Quality

5.2.1 Material and Finished Surface

In a 40mm diameter zone centered around the distance reference point and in a 30mm zone around the near reference point, the lens blank when inspected using the method of 6.1 shall not exhibit any defect internally or on the finished surface which can impair the vision in the as-worn position.

5.2.2 Unfinished Surface

The surface quality of the unfinished lens blank surface shall be of sufficient quality to allow inspection of the lens blank, determine add power, and allow the use of projection type layout markers.
5.3 Geometric Tolerances

5.3.1 Size of Blank

It is necessary to distinguish between three sizes:

marked or nominal size (dn): dimension(s) indicated by the manufacturer.

effective size (de): actual dimension(s) of the lens blank.

usable size (du): optically usable dimension(s) owing to the presence of bevel, edge defects, etc. Isolated peripheral flaws, chips and bubbles are acceptable.
5.3.1.1 Tolerances on Minimum Size

Effective size: \( de \geq dn - 1\text{mm} \)

Usable size: \( du \geq dn - 1\text{mm} \) (\( dn \leq 65\text{mm} \))

\( du \geq dn - 2\text{mm} \) (\( dn > 65\text{mm} \))

(Note: lenses with a carrier curve are exempt from the tolerance on usable size)

5.3.2 Blank Thickness

The thickness of the lens blank shall be measured at the point specified by the manufacturer. The measured thickness shall not be less than the specified minimum thickness.

5.4 Optical Field Characteristics of Progressive Addition Lenses

The optics of progressive addition lenses are complex and vary across the surface of the lens. There are several methods of measuring and representing the aspects of these optics across the optical field. The characteristics to be measured are: (1)
5.4.1 Sphere

Sphere represents the spherical equivalent power at any point on the lens surface.

5.4.2 Astigmatism

The maximum difference in diopters between meridional powers and the direction of the principal meridian in degrees at any point on a lens.

5.4.3 Prism

The magnitude of the deviation in prism diopters and the direction of the deviation in degrees of a ray of light through a specified point on a lens.

6 Test Methods

6.1 Material and Surface Quality

The lens inspection is carried out at a light/dark boundary and without the aid of magnifying optics. The inspection should take place in room lighting.
of about 200 lux. The inspection light should be either a fluorescent tube with a minimum of 15 W or an open-shaded 40 W incandescent clear lamp. The lens position should be about 305 mm (12 inches) from the light source and viewed against a dark background. This observation is subjective and requires some experience.

6.2 Measurement Method for Surface Power at the Distance Reference Point

The surface power at the distance reference point is determined using any method of sufficient accuracy. An example of one such method is measurement of the concave spherical curve, center thickness, and back vertex power, and then calculating the convex surface power.

7. Marking of the Semifinished Blank

7.1 Required Permanent Marking

7.1.1 Horizontal Reference Marking
7.1.2 Add Power Inscription
7.1.3 Manufacturer, supplier, tradename or trademark inscription.
7.2 Required Non-Permanent Marking

7.2.1 Horizontal Reference Marking
7.2.2 Indicator of the Distance Reference Point
7.2.3 Indicator of the Near Reference Point
7.2.4 Indicator of the Fitting Point
7.2.5 Indicator of the Prism Reference Point

8 Identification of the Semifinished Blank

8.1 Identification required on the package

8.1.1 Nominal Surface Power
8.1.2 Blank Size
8.1.3 Color
8.1.4 Material, manufacturer's or supplier's tradename or equivalent
8.1.5 Add Power
8.1.6 Style Designation or Trademark
8.1.7 Left or Right Eye (if applicable)

8.2 Information available from the manufacturer on request
8.2.1 Center Thickness

8.2.2 Edge Thickness

8.2.3 Surface Power

8.2.4 Optical Properties (refractive index, constringence, transmittance)

8.2.5 If applicable, the manufacturer must also provide the thickness reduction prism that can be used to achieve the minimum edge thickness.

8.2.6 Optical Field Characteristics

9 Identification of the Standard

If the manufacturer or supplier claims compliance to this standard, then references shall be made to this standard, either on the package or in the available literature.
Decreasing radius due to add power creates thinner edge at bottom of progressive lens than a single vision lens requiring thicker edge at top to achieve full lens size.

Increased vertical prism distributes edge thickness more evenly.
Solid lines: Non-Permanent Ink Markings
Dotted lines: "Engraved" Permanent Markings

Near Reference Point

Prism Reference Point

Sitting Center

Fitting Point

Distance Reference Point

Add Power

Horizontal Reference Markings

1000 2000 3000 4000